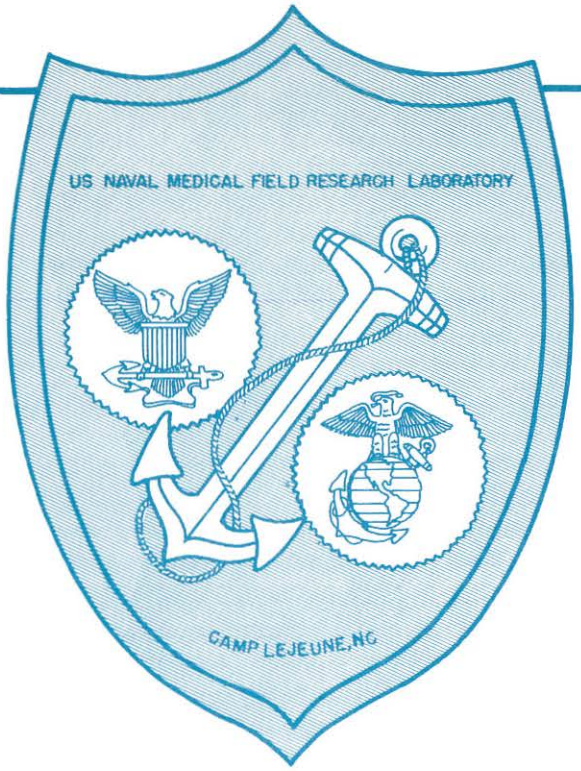

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DETERMINANTS OF SICKNESS IN MARINE RECRUITS

by

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DETERMINANTS OF SICKNESS IN MARINE RECRUITS[1]

G. T. STEWART[2], A. W. VOORS[3], C. D. JENKINS[4], R. R. GUTEKUNST[5], AND C. F. MOLDOW[6]

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Stewart, G. T. (Tulane Univ. School of Public Health and Tropical Medicine, New Orleans, La. 70112), A. W. Voors, C. D. Jenkins, R. R. Gutekunst and C. F. Moldow. Determinants of sickness in Marine recruits. *Amer. J. Epid.*, 1969, 89: 254–263.—Is the human environment, as expressed by social and cultural attributes of defined groups, a more potent determinant of sickness than the conventionally attributed single causes like microorganisms, individual disposition and proneness to accident or exposure to its risk? These two alternatives can be tested in Marine recruits where the defined, face-to-face group is the platoon, isolated from other platoons but otherwise highly comparable. Sickness in the platoon was indexed by the number of sick calls and each sick call was categorized by the supervising personnel into: a) infectious, b) skin, c) other non-traumatic, d) musculo-skeletal or traumatic, and e) unspecified complaints. Under the single-cause-single-effect hypothesis, differences in amount of sickness between platoons are explained by introductions of infectious diseases or by differences in the drill procedure leading to differential sickness rates of the musculo-skeletal and trauma complaint type. Thus, this hypothesis predicts that in a given platoon a high sickness rate of one complaint type is unlikely to be accompanied by a high rate of another complaint type, unless the two single causes involved both happen to act excessively on the same platoon. Likewise, the hypothesis predicts that the time of peak sick call incidence for one complaint type is unlikely to coincide with the time of peak incidence for another complaint type. The alternative hypothesis—that the cause of increase of a sickness in a recruit group is largely nonspecific—predicts an association between the sick call rates of various complaint types in the same platoon, and a similarity of training stages having peak sick call incidences of the various complaint types. A similar reasoning holds for the time of peak incidence of sickness comparing one platoon with another. In each platoon the respective percentages of sick calls where the recruit was ordered to be admitted to the hospital, to have no duty, to have light duty, or to go back to full duty were essentially similar, and this similarity in relative distributions of recruit disposal was also observed when comparing the various stages of training. This supports the contention that in this study the number of sick calls per platoon is a valid index of

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sickness in the platoon. A three-way analysis of variance of the number of sick calls per platoon was performed and the main effects due to complaint type, platoon, and stage of training were assessed, as well as their first-order interactions. For all complaint types, the maximum number of sick calls in most of the platoons occurred during the second and third week of training and the minimum number during the sixth and seventh week. The training-stage by complaint-type interaction was small compared to the main effects themselves. In addition, there was a significant main effect due to platoons, whereas the platoon by complaint-type and the platoon by training-stage interactions were small. These findings contradict the single-cause-single-effect and support the alternative hypothesis. The analysis of variance of platoon sickness, as indicated by number of sick calls, provides a test for the two competing hypotheses of causation.

epidemiology; etiology; infection; military personnel; psychology; sociometric technics; statistics

Studies of the incidence of disease in various communities increasingly emphasize the human environment as a potent determinant of health. To bring this general theory to a test, specific hypotheses need to be stated in precise operational terms, and a number of strictly comparable groups need to be observed in terms of various possible health determinants in relation to changes in their states of health.

A human environment appropriate to this purpose is found in the training center for Marine recruits; here, personnel-selection and way of life are under sufficiently strict control as to approximate experimental conditions. The face-to-face group is the platoon, comparable to other platoons in many aspects of life including place and time, and yet physically isolated from these other platoons in its living quarters. Each platoon follows a virtually identical day-to-day training program. In the study reported here, the reasons for calls at the sick bay are analyzed according to their nature, time and distribution between platoons to see if any common explanatory factors can be identified. To avoid dislocation of routine we confined our sickness data to that which is routinely registered in the sick bay of the training base at Parris Island, South Carolina.

Setting

The recruits arrive at their training center (Parris Island, S.C.) in buses from their respective places of origin. Platoons of 85 men are formed as the recruits arrive. Thus, in essence, the composition of platoons occurs in unselected fashion with some bias toward place of origin. Each platoon has one Non-Commissioned Officer staying with the platoon as instructor for the entire training period of eight weeks. In addition, two Non-Commissioned Officers work in shifts with this platoon as instructors. The platoons are housed in series of four in barracks accommodating some 340 men. Within these barracks the individual platoons remain separated from each other. The recruits are housed in the same barracks for the entire eight-week training period, except for a ten-day period of rifle training during the fifth and sixth week, at which time they live elsewhere on the camp in similar barracks.

Permission to report for "sick call" is granted by the Non-Commissioned Officer who writes the presenting complaint on a "sick slip". Five types of complaints were distinguished, assumed to represent the disease classification implied under the first hypothesis: 1) respiratory and gastro-intestinal, 2) skin, 3) other non-traumatic, 4) musculo-skeletal and traumatic, and 5) unknown complaints. The medical staff at

the dispensary fills out the disposal of the recruit to duty, light duty, hospital, etc., and his prescribed therapeutic course of action.

All platoons between mid April and mid August, 1967 (60 Platoons in total, comprising three battalions) were included in the study.

Method

All sick slips were analyzed as to type of presenting complaint, platoon identification, weeks since platoon was formed, and disposal. Disposal—the orders received by the recruit from the medical staff, either to be admitted to the hospital, to have no duty, to receive special treatment, to have light duty, or to go back to full duty—was used to validate the number of sick calls per platoon as an index of sickness in the platoon.

An attempt was made to quantify the share in disease determination contributed respectively by the complaint-specific disease agents, the particular platoon, and the general training setting. To this end the variance of the sick call rate per platoon was analyzed for the effects of "complaint type", "platoon" and "stage of training", and their first-order interactions. In order to obtain homoscedasticity, to normalize the distribution, and to permit cell entries which would be zero otherwise, a log (x + 1) transformation was applied, where x is the number of sick calls, being the dependent variable. For this analysis of variance, the time of training was subdivided into fortnights rather than weeks.

Hypotheses. We wish to test with these data two alternative hypotheses: 1) The doctrine of specific etiology, i.e. that the predominant cause of an increase of an illness in a recruit group is one specific agent, be it a micro-organism, an accident or a constitutional factor (the one-cause-one-effect hypothesis); 2) The cause of increase of an illness in a recruit group is largely nonspecific and associated mainly with the human environment as reflected in the sequence of training since the platoon's formation and the particular platoon (the nonspecific-cause-multiple-effect hypothesis). This hypothesis is the opposite of the first one in that it assumes absence of monistic etiology.

Inferences implicit in the hypotheses. Under the one-cause-one-effect hypothesis, either the presence of epidemics of infectious diseases or differences in the drill procedure causing differential rates of musculo-skeletal and trauma complaints would lead to significant differences between sick calls per platoon for the complaints concerned. Thus, this hypothesis entails strong complaint-type by platoon interaction: it is surmized that the mean proportions of the various complaint-types differ between platoons, as a consequence of the different exposure of separate groups to specific causes of disease.

On the other hand, under the nonspecific-cause-multiple effect hypothesis which postulates that the same "agent" can cause different diseases or complaint-patterns in different persons, observed differences in number of sick calls between platoons are explained by differing "human environments". Thus, the hypothesis entails that—given random distribution of the human constitution and absence of "focal epidemics" defined in the same broad sense basic to the first hypothesis—there will be at most only weak platoon by complaint-type interaction. In effect, there will be only slight differences between platoons in their relative distributions of complaints.

Similar reasoning can be applied to the interactions between complaint-type and training-stage and between platoon and training-stage in their respective effects on the rate of sick calls per platoon.

These two alternative hypotheses with their consequences expressed in terms that can be tested by the data are summarized in figure 1.

Results

Sick calls by week of training and by complaint. The total numbers of sick calls

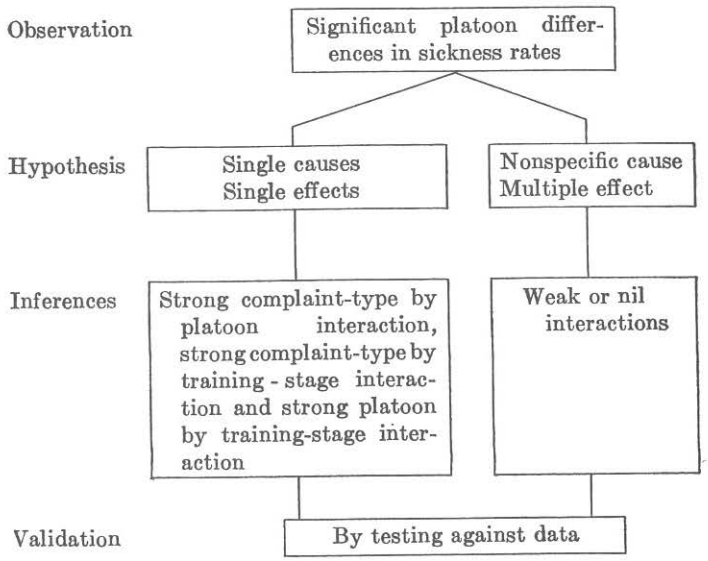

FIGURE 1. Inferences from alternative hypotheses about causes of complaints.

by week and by complaint are given in figure 2. It appears that there is a consistent time pattern: most sick calls are made during the second and third week and least during the sixth and seventh, when instruction was given at the rifle range. Another conclusion from this figure is that there is a remarkable similarity in chronology for all types of complaints.

Sick calls by week of training and by disposal. The total numbers of sick calls by week and by disposal are given in figure 3. Again, there is a remarkable similarity in chronology for all levels of severity of illness as indexed by disposition of complaint.

Sick calls by complaint and by disposal. The average number of sick calls per platoon by presenting complaint and by disposal are given in table 1, and the range of these numbers in table 2. The reasons for the recruits to report sick, as expressed in type of complaint, appeared unrecorded and hence unknown to the investigator in almost half of the instances. Of the remainder, the majority were accounted for by skin disorders or musculo-skeletal complaints, including trauma. It is also apparent from these tables that the presenting complaints with the more serious consequences as evidenced in the disposal were either musculo-skeletal-traumatic or "unknown" (in terms of the present coding).

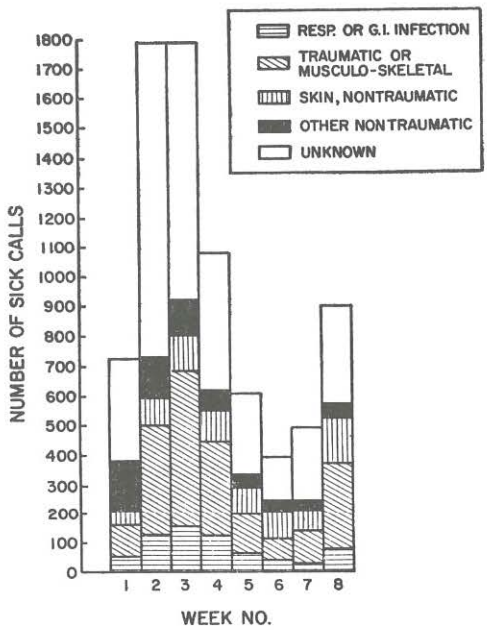

FIGURE 2. Recruit sick calls by week of training and by type of complaint. Parris Island, S. C., April–August, 1967.

Platoon effect on traumatic and musculo-skeletal sick calls. The questions

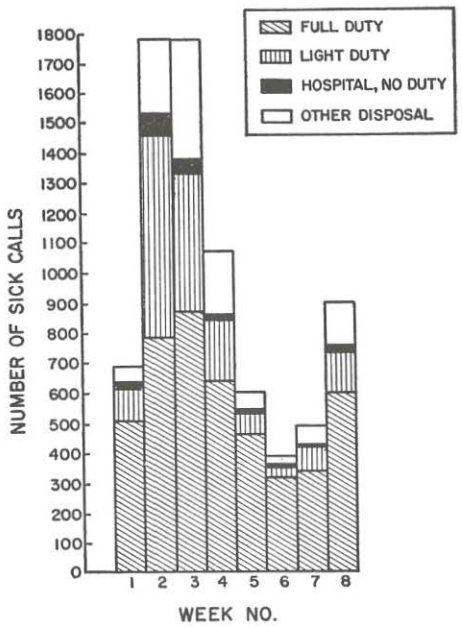

FIGURE 3. Recruit sick calls by week of training and by disposal. Parris Island, S.C., April–August, 1967.

TABLE 1

Average number of sick calls per platoon, by type of presenting complaint and by disposal

Type of presenting complaint	Disposal				
	Duty	Light duty	No duty or hospital	Other (frequent soaks, etc.)	Totals
Respiratory	4.8	1.2	0.2	0.2	6.4
Gastro-intestinal	4.5	0.9	0.1	0.6	6.1
Skin	12.9	0.6	0.2	1.6	15.3
Psychiatric	1.3	0.2	0.0	0.0	1.5
Dental	2.1	1.1	0.2	0.0	3.4
Other non-traumatic	9.8	1.1	0.2	0.7	11.8
Musc-skel. or trauma	19.7	4.6	0.7	10.6	35.6
Unknown, not recorded	31.4	22.5	2.3	9.2	65.4
Totals	86.5	32.2	3.9	22.9	145.5

arise: 1) does the number of traumatic and musculo-skeletal sick calls vary by platoon and, if so, 2) does this represent merely "epidemics" of complaining or does

TABLE 2

Range of number of sick calls per platoon by type of presenting complaint and by disposal

Type of presenting complaint	Disposal				
	Duty	Light duty	No duty or hospital	Other (frequent soak, etc.)	Total
Respiratory	0–21	0–6	0–1	0–3	0–30
Gastro-intestinal	0–16	0–2	0–1	0–7	0–20
Skin	0–28	0–3	0–1	0–6	0–40
Psychiatric	0–10	0–1	0	0–1	0–10
Dental	0–8	0–5	0–2	0	0–10
Other non-traumatic	0–24	0–4	0–2	0–5	1–31
Musc-skel. or trauma	3–50	0–10	0–4	0–23	13–77
Unknown, not recorded	10–65	11–39	0–8	0–22	28–141
Totals	27–149	15–66	0–10	10–42	67–247

it represent epidemics of sickness which prevents the disposal "back to full duty".

To answer these questions, for each platoon the number of these sick calls was plotted against its proportion ordered "back to full duty". It appears that there is no association between proportion ordered back to full duty and number of musculo-skeletal or traumatic sick calls per platoon (figure 4); the correlation coefficient is 0.17 and is clearly non-significant. In addition a two-way analysis of variance of the traumatic or musculo-skeletal sick calls was performed for each battalion separately (table 3). In all cases the main platoon effect was significant at the 5 per cent level, when disposal was taken into account. The statistically significant main effect of disposal in two of three battalions simply means that the sick calls were not equally distributed into the types of disposal as here grouped into two categories. Type of disposal is here used as a control variable to permit a test of differences among platoons unaffected by severity of the case. Thus there is significant difference between platoons in number

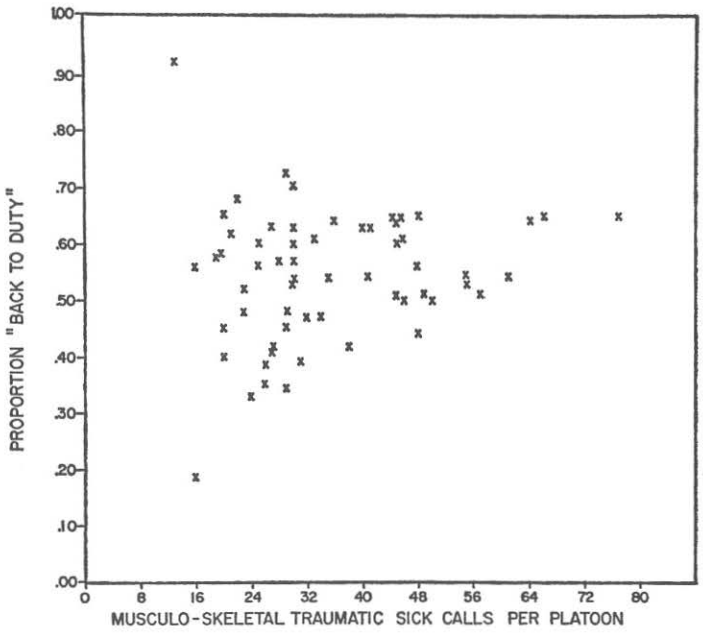

FIGURE 4. Platoons by number of sick calls due to musculo-skeletal or traumatic complaints and by the proportion of these sick calls that was ordered back to full duty immediately. Parris Island, S.C. April–August, 1967.

of traumatic and musculo-skeletal sick calls, leading to the difference in reported sickness between platoons.

Disruption of daily duty in relation to complaint. In order to compare the presenting complaint types as to the degree to which they disrupt the daily duty, the various disposals were weighed as follows:

Disposal	Weight
Back to full duty	1
Light duty	2
Other (frequent soaks, etc.)	3
No duty or hospital	4

In this respect the question arose to what extent musculo-skeletal and traumatic sickness was associated with the total other sickness experience. For each platoon separately these two characteristics were plotted against each other (figure 5). There appears to be a clear association (correlation coefficient is 0.46, which is statistically highly significant). This means that the high rates of traumatic sick calls occur mostly in the same platoons that have high rates of non-traumatic sick calls. There is either a common factor in the etiology of a wide variety of kinds of illness, or there are group-specific factors affecting "host resistance" to "causes of illness."

TABLE 3

Anova tables for sick calls with musculo-skeletal or traumatic complaints per platoon, by platoon and disposal, each battalion being analyzed separately

Battalion	Variance due to	S.s.	D.f.	M.s.	V.r.	Fc (α = .05)
1	Disposal	133.23	1	133.23	3.89	4.38
	Platoons	2,049.48	19	107.87	3.15	2.18
	Error	650.27	19	34.22		
	Total	2,832.98	39			
2	Disposal	81.00	1	81.00	5.52	4.45
	Platoons	1,657.89	17	78.95	5.38	2.28
	Error	308.00	17	14.67		
	Total	2,046.89	35			
3	Disposal	196.57	1	196.57	6.56	4.32
	Platoons	1,924.98	21	91.67	3.06	2.08
	Error	629.43	21	29.97		
	Total	2,750.98	43			

Disposal in platoons with extreme sick calls. Are the platoons with extreme numbers of sick calls different as to disposal?

The frequency distribution of sick calls

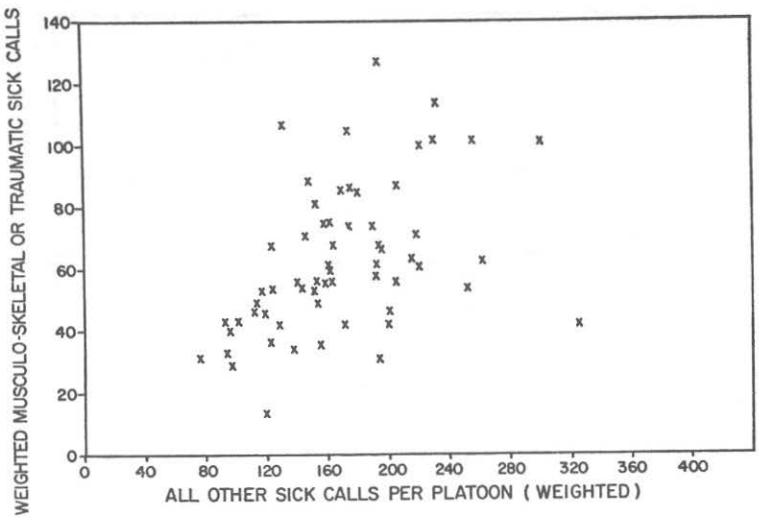

FIGURE 5. Platoons by weighted sick calls due to musculo-skeletal or traumatic complaints and by weighted sick calls due to all other complaints. Parris Island, S.C. April–August 1967.

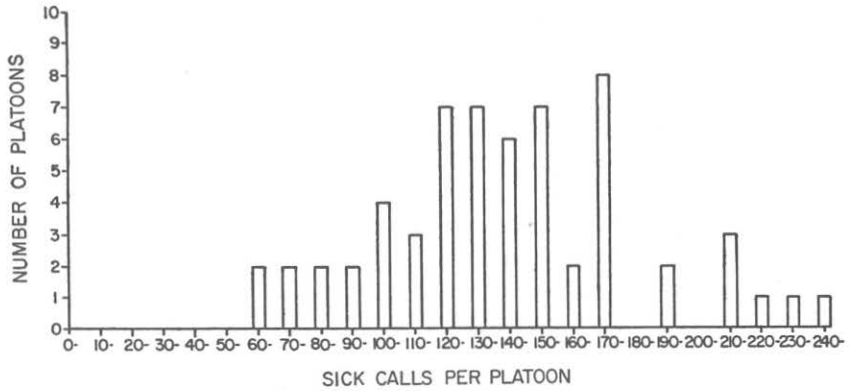

FIGURE 6. Frequency distribution of sick calls over the 60 platoons under study. Parris Island, S.C., April–August 1967.

per platoon is given in figure 6. The platoons were divided into three categories: 1) The eight platoons with least sick calls; 2) the eight platoons with most sick calls; and 3) all other platoons. Thus, sick calls were tabulated by disposal. In addition, these figures are specified for the complaint category "trauma and musculo-skeletal" (table 4). For all complaint categories the platoons with the most sick calls have a slightly higher percentage of disposals "back to full duty." A similar conclusion holds for the traumatic and musculo-skeletal complaints.

Assessment of two-factor interactions between the effects of complaint-type, platoon, and training stage on the number of sick calls. A three-way analysis of variance of sick calls as affected by type of complaint, by fortnight of the training sequence, and by platoon results in significance at the 5 per cent level of the three main effects (table 5).

The complaint-by-platoon interaction can be assessed by assuming the three-factor interaction to be zero, using this term as the "error" term. In that case, this would have resulted in a relatively weak

complaint-by-platoon interaction, just significant at the 5 per cent level.

However, the main effect due to stage of training (fortnight) is strong and highly significant (table 5). Therefore, this "fortnight" factor may have inflated the three-factor interaction used as the error term, and hence the complaint-by-platoon interaction may have been stronger than was apparent. In order to investigate this possibility, the influence of fortnight on the complaint-by-platoon interaction was assessed by performing a two-way Anova of complaint and platoon effects for each fortnight separately (table 6). The results show a consistent pattern of mean squares for each fortnight respectively, and hence it can be concluded that, indeed, there is no strong complaint-by-platoon interaction.

It is also apparent from table 6 that the main effect of platoon on sick call increases as time progresses (the variance ratio is, in the sequence of the fortnight, respectively: 1.2, 2.5, 2.6, and 3.3, all, except the first, being significant at the 5 per cent level). This observation supports the conclusion that the human environment, i.e. the platoon, has a pronounced and accumulating influence on the number of sick calls. Similar observations can be made with regard to the complaint-type by train-

TABLE 4

*Mean sick calls per platoon by sick call quantity category and by disposal**

Sick call quantity category	Disposal		
	Total disposals	"Back to full duty"	Per cent† of totals
8 platoons with least sick calls	79.4 (19.0)	43.0 (10.1)	54 (53)
All platoons not mentioned above nor below	158.2 (35.0)	93.0 (19.0)	59 (54)
8 platoons with most sick calls	217.0 (54.8)	135.6 (32.4)	63 (59)
Totals	145.0 (35.5)	86.3 (19.6)	60 (55)

* Figures for musculo-skeletal and traumatic sick calls only are given within parentheses.

† The percentages of sick calls returned to full duty differ significantly among these three categories of platoons (Chi-square with 2 d.f. is 15.18).

TABLE 5

Three-way Anova table of sick calls by complaint-type, by platoon, and by fortnight (see also table 6)

Variance due to	S.s.	D.f.	M.s.	V.r.
Complaint type	48.5218	4	12.1305	166.9
Platoon	19.4920	59	0.3304	4.5
Fortnight	24.9982	3	8.3327	114.6
Comp × Pl	22.1771	236	0.0940*	1.3
Comp × Fn.	12.7234	12	1.0603*	14.6
Pl × Fn.	20.9779	177	0.1185*	1.6
Cp × Pl × Fn	51.4818	708	0.0727*	
Totals	200.3722	1199		

* The F-test, performed under the assumption that the three-factor interaction is zero and that this term therefore represents the error term, results in significance of all two-factor interactions at the 5% level of significance, although most of these interactions are relatively weak (see text).

TABLE 6

Two-way Anova of sick calls by complaint and by platoon, performed for each fortnight separately

Fortnight No.	Variance due to	S.s.	D.f.	M.s.	V.r.
1	Complaint type	14.7789	4	3.6947	29.9
	Platoon	8.4312	59	0.1429	1.2
	Error	29.1906	236	0.1237	
2	Complaint type	24.5252	4	6.1313	121.4
	Platoon	7.5290	59	0.1276	2.5
	Error	11.9294	236	0.0505	
3	Complaint type	8.0123	4	2.0031	35.1
	Platoon	8.8592	59	0.1502	2.6
	Error	13.4481	236	0.0570	
4	Complaint type	13.9424	4	3.4856	43.1
	Platoon	15.6652	59	0.2655	3.3
	Error	19.0797	236	0.0808	

ing-stage interaction and the platoon by training-stage interaction.

Discussion

The hypothesis that the excess of sick calls in a platoon is likely to have a specific main cause—be it infectious or traumatic—and is likely to occur during a time in the training peculiar to this platoon, is not supported by the data. On the contrary, the main noxa appeared to be somehow mediated through week of training and platoon uniqueness and to manifest itself in a multiplicity of complaint options.

In respiratory infectious diseases, the theory that the human environment, embodied in the face-to-face groups, is a potent determinant of health, was advanced by Holmes and associates (1–3) and later supported by the findings of Mason and coworkers (4, 5). Yet this type of infectious disease may be an inappropriate variable for testing this theory, since the very face-to-face group which offers a human environment conducive to infectious disease is also the one which harbours most infective human hosts and hence is the richest source of microbial agents. Thus, the familiar observation that one platoon manifests an infectious epidemic while another platoon in the same setting does not, could be explained alternatively by postulating that in the first platoon the combination of man-to-man contact, susceptibility and communicability cooperates in surpassing a certain epidemic threshold while in the second platoon this threshold is not reached (6, 7).

In view of this possible ambiguity in explaining the observed group differences in incidence of infectious disease, the present study was concerned also with the incidence of non-infectious diseases. The observed results in this respect reveal no major differences in chronology and form of complaints between platoons and conform in this respect to the pattern expected under the nonspecific-cause-multiple-effect hypothesis. In the absence of more precise information about the origins, nature and sequence of the complaints registered, the causes and effects cannot be identified except in broad headings within which other factors can operate. For instance, a constitutional disability may affect alertness or performance and so predispose to an injury or psychosomatic complaint which would then in our data, mask the underlying cause. However, the net result is a complaint, so ignoring these subtler mechanisms, we can say that the differences in patterns of complaints between platoons in this study appear to arise from a number of factors operating within the platoons; a considerable proportion of these complaints are listed here as "unknown" in etiology. The extent to which these and other complaints reflect a personal or group reaction to circumstances within the platoon rather than to more specific hazards would require a much more intimate investigation.

The use of complaints instead of diagnoses is an unusual feature of the present study but for the purpose of relating official reaction (i.e., disposal) to individual action (i.e., the Marine's complaint), it has certain advantages in that the complexities and preconceptions implicit in etiologic classification are by-passed. The results show clearly that the frequency of complaints is a function of stage of training and of the platoon itself, i.e. the human environment. The physical environment for the different platoons in this study was virtually a constant, and hence cannot be used to explain the observed variability. However, the symptoms associated with the complaints are distributed in equal proportions among the recruits when each platoon-week is considered separately, suggesting that some individuals were reacting differently to similar causal factors.

Summary and conclusion

The sick calls made by Marine recruits at Parris Island, South Carolina in the winter of 1966–1967 were classified accord-

ing to chief complaint into five main groups: 1) respiratory and gastro-intestinal complaints, 2) skin, 3) other non-traumatic, 4) musculo-skeletal and traumatic, and 5) unknown complaints. Etiologically, the disability corresponding to these groups should differ between platoons in causation and pathology. There was, however, only weak interaction statistically between the effects of "complaints" and "platoons" upon the incidence of sick calls. This suggests that single causes (e.g. microbial infection, constitutional defects, accidents) were comparatively unimportant in giving rise to the group variability in complaints and disabilities. The data support the alternative hypothesis: that complaints and disabilities arose from non-specific causes having multiple effects which were influenced, despite uniformity of training schedules, by time sequence and group characteristics comprising the "human environment" of each platoon. As the training progressed this platoon effect increased.

It was found also that the percentages of recruits-with-complaints ordered to have no duty, to have light duty, or to go back to full duty were essentially similar for each platoon and each stage of training. Although there were small but statistically significant differences in average severity of sickness between platoons with extremely few and those with extremely many sick calls (table 4), this finding does not seriously weaken the contention that in this study the number of sick calls per platoon is a valid index of sickness as judged by the medical personnel. The method used in this study may therefore have wider application in estimating fitness in relation to personal and environmental factors.

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